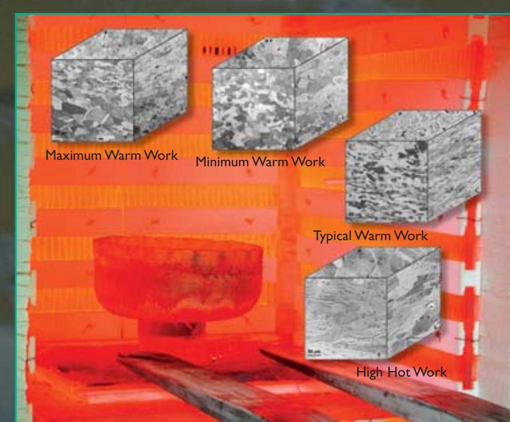
Materials Science and Technology Division

Understanding Actinide Materials

Actinide materials science in the Materials Science and Technology Division spans the continuum from fundamental condensed-matter physics to manufacturing. In partnership with scientists and engineers from several other Los Alamos divisions, materials researchers measure the properties of uranium and plutonium to understand their dynamic behavior. Such understanding gives insight into the performance of actinide-based weapons components fabricated at Los Alamos.

Studying Uranium and Plutonium

At Los Alamos, materials researchers study uranium and plutonium on scales ranging from single crystals to manufactured parts.

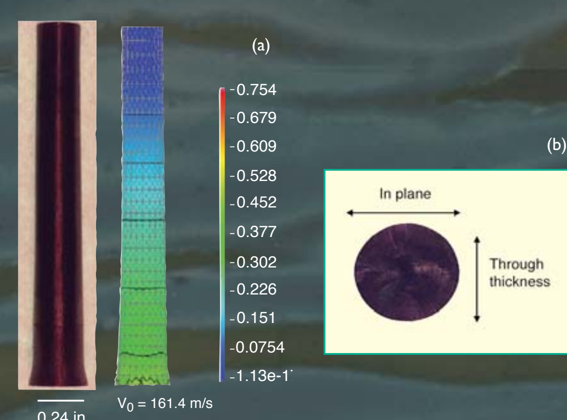


Determining the Effects of Processing

These metallographic images, shown here superimposed on an image of a glowing hemishell of uranium, demonstrate that differences in processing conditions can change the microstructure of uranium. Because such changes directly affect relevant properties of uranium, such as dynamic response, fabrication and characterization must be tightly coupled.

Measuring Performance

Uranium and plutonium are highly anisotropic (that is, they exhibit different properties in different directions). The degree of the anisotropy depends upon processing conditions. Constitutive models now include anisotropy and are validated against deformation measurements.

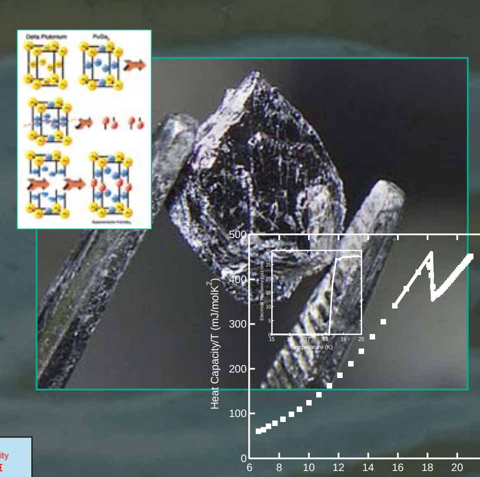


Modeling and Measuring Mechanical Response

(a) An experimental shape (left) is compared with the calculated shape based upon the anisotropic model of the material s properties. (b) The footprint of a deformed uranium sample shows its anisotropic strain developed in response to testing. The short axis of the ellipse corresponds to the thickness direction of the plate from which the sample was machined.

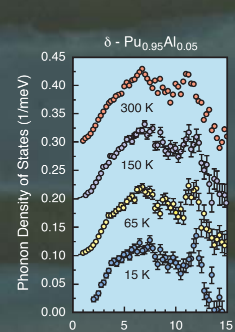
Outstanding Questions Answered by Fundamental Science

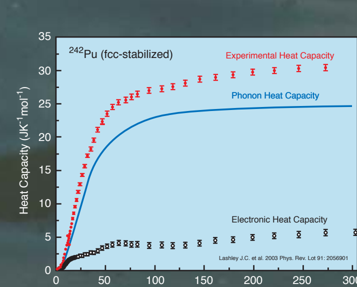
The complexity of plutonium and uranium, due in part to the varying degree to which 5f electrons contribute to chemical bonding and materials stability, makes for both complex metallurgy and unusual properties.



Discovering Superconductivity

A layered version of the cubic phase of plutonium displays high-temperature superconductivity because of the metal s changing chemical bonding. The upper left inset shows schematically the relationship between delta plutonium and the superconductor $PuCoGa_5$, a crystal of which is shown in the photo. The lower right plot shows evidence for superconductivity.





Separating Contributions to Plutonium Heat Capacity

Recent fundamental neutron-scattering and thermodynamic measurements on plutonium (left) allow the lattice (phonon) and electronic contributions to the heat capacity of plutonium to be separated (right).

David Teter, teter@lanl.gov, 505 665 0160
George T. Gray III, rusty@lanl.gov, 505 667 5452
Jason C. Lashley, j.lash@lanl.gov, 505 665 6469
John L. Sarrao, sarrao@lanl.gov, 505 665 0481

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